
02200 - EARTHWORK

(Revised 09/15/03)

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PART 1 – GENERAL

The Contractor shall furnish all labor, materials, and equipment to perform all work for all site clearing, site excavation, grading and embankment, excavation and filling and backfilling for structures. Complete all as shown on the contract drawings and in accordance with these Specifications and completely coordinated with all other trades.

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Requirements and Supplementary Conditions applicable to this specification.
- B. Section 01000 – General Requirements.
- C. [Section 02220](#) – Trenching, Backfilling, and Compaction of Utilities.
- D. [Section 02660](#) – Water Distribution.
- E. [Section 02730](#) – Sanitary Sewer.

1.2 SUMMARY

- A. This section includes:
 - 1) Site clearing and grubbing.
 - 2) Stripping and stockpiling topsoil.
 - 3) Excavation and embankment placement.
 - 4) Preparing subgrades for pavements, walks, curb & gutter, and turfed areas.
- B. Construction and materials related to this section but specified in other sections:
 - 1) Landscaping, Seeding, and Groundcover: Section 01000 - *General Requirements*.
 - 2) Erosion Control: See Section 01000 - *General Requirements*.

1.3 DEFINITIONS

For the purposes of this specification, the following definitions refer to earthwork that come under the authority of the City of Lynchburg, Virginia as specified within this section and other sections of this manual.

- A. **Borrow:** Borrow excavation shall consist of approved select fill material imported from off-site.
- B. **Clearing:** Clearing shall consist in the felling, cutting up, and satisfactory disposal of trees and other vegetation designated for removal in accordance with these specifications.
- C. **Fill (in terms of volume):** In terms of volume, fill is defined as a compacted post-construction volume in-place.
- D. **Grubbing:** Grubbing shall consist of the removal of roots 1 ½ inch and larger, organic matter and debris, and stumps having a diameter of three inches or larger, to a depth of at least 18 inches below the surface and or subgrade; which ever is lower, and the disposal thereof.
- E. **Regular Excavation:** Removal and disposal of any and all material above subgrade elevation, except solid rock and undercut excavation, located within the limits of construction.
- F. **Rock Excavation:** Removal and satisfactory disposal of all unsuitable materials, which, in the opinion of the City Engineer, cannot be excavated except by drilling, blasting, wedging, jack hammering or hoe ramming. It shall consist of undecomposed stone, hard enough to ring under hammer. All boulders containing a volume of more than ½ cubic yard and/or solid ledges, bedded deposits, unstratified masses and conglomerations of material so firmly cemented as to possess the characteristics of solid rock which cannot be removed without systematic drilling, blasting, or hoe ramming will be classified as rock.
- G. **Select Fill Material:** Nonplastic material obtained from roadway cuts, borrow areas, or commercial sources used as foundation for subbase, shoulder surfacing, fill, backfill, or other specific purposes.
- H. **Structures:** Incidental buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. **Subgrade:** Surface or elevation remaining after completing the excavation, or top surface of a fill or backfill immediately below subbase or topsoil materials, as applicable.

- J. **Topsoil:** Topsoil shall consist of friable clay loam, free from roots, stones, and other undesirable material and shall be capable of supporting a good growth of grass.
- K. **Undercut Excavation:** Undercut excavation shall consist of the removal and satisfactory disposal of all unsuitable material located below subgrade elevation. Where excavation to the finished grade section results in a subgrade or slopes of muck, peat, matted roots, etc., the Contractor shall remove such material below the grade shown on the plans or as directed; and areas so excavated shall be backfilled with approved select borrow as ordered by the City Engineer.

1.4 SUBMITTALS

- A. Submit product data and a sample of separation fabric and fully document each with specific location or stationing information, date and other pertinent information.
- B. **Product Data**
 - 1) Stabilization/Separation fabric
- C. **Material Test Reports:** Provide from a qualified testing agency test results and interpretation for compliance of the following requirements indicated:
 - 1) Classification according ASTM D2487 of each on-site or borrow soil proposed for backfill, unless otherwise directed by the City Engineer.
 - 2) Laboratory compaction curve according to ASTM D698 for each on-site or borrow soil material proposed for fill or backfill.
 - 3) Laboratory compaction curve according to ASTM D1557 for each on-site borrow soil material proposed for fill and backfill.
- D. **Blasting:** See Section 01000 – *General Requirements*.

1.5 QUALITY ASSURANCE

- A. **Geotechnical Testing Agency Qualifications:** An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing as documented according to ASTM D 3740 and ASTM E 548.
- B. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.
- C. The Contractor shall comply with the latest revision of the Virginia Occupational Safety and Health Standards for the Construction Industry as adopted by the Safety and Health Codes Commission of Virginia.
- D. The Contractor shall comply with Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, "Virginia Erosion and Sedimentation Control Handbook," latest revision.

- E. Comply with applicable requirements of NFPA 495, *"Explosive Materials Code."*
- F. Materials and operations shall comply with the latest revision of the Codes and Standards listed below:

American Society for Testing and Materials

ASTM C 33	Concrete Aggregates
ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates Sieve Analysis of Fine and Coarse Aggregate
ASTM D 422	Standard Test Method for Particle-Size Analysis of Soils (for classification purposes only)
ASTM D 698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³) (Standard Proctor)
ASTM D 1556	Standard Method of Test for Density of Soil in Place by the Sand-Cone Method
ASTM D 1557	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (Modified Proctor)
ASTM D1883	Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils
ASTM D 2049	Standard Method of Test for Relative Density of Cohesionless Soils
ASTM D2167	Standard Method of Test for Density of Soil in Place by the Rubber-Balloon Method
ASTM D 2487	Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D 4254	Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D 4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

American Association of State Highway & Transportation Officials

AASHTO T 99	The Moisture-Density Relations of Soils using a 5.5-pound hammer and a 12-inch drop
AASHTO T 180	The Moisture Density Relations of Soils using a 10-pound hammer and an 18-inch drop
AASHTO M 145	The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes

1.6 STANDARD ABBREVIATIONS

ANSI	American National Standards Institute
AREA	American Railway Engineers Association
DCR	Virginia Department of Conservation and Recreation
MSDS	Material Safety Data Sheets
OHSA	Occupational Safety and Health Administration
VDH	Virginia Department of Health
VDOT	Virginia Department of Transportation

1.7 TESTING SERVICES

- A. The Testing Laboratory shall be approved by the City Engineer and will be responsible for conducting and interpreting tests. The Testing Laboratory shall state in each report whether or not the test specimens conform to all requirements of the Contract Documents and specifically note any deviation.
- B. Specific test and inspection requirements shall be as specified herein.

1.8 PROJECT CONDITIONS

- A. **Demolition:** Demolish and completely remove from the site existing utilities, structures or surface features indicated on the plans to be removed. Coordinate with applicable utility companies to shut off services if lines are active.
- B. **Environmental:** Before crossing or entering into any jurisdictional wetlands, Contractor shall verify whether or not a wetlands permit has been obtained for the encroachment and whether special restrictions have been imposed. Care shall be taken to prevent draining or otherwise destroying non-permitted wetlands. Restore as stated on either the project drawings, the contract documents, and/or as noted in the permit.

C. Geotechnical Investigation

- 1) Where a Geotechnical report has been provided to the Contractor, the data on sub-surface soil conditions is not intended as a representation or warranty of the continuity of such conditions between borings or indicated sampling locations. It shall be expressly understood that the City of Lynchburg will not be responsible for any interpretations or conclusions drawn there from by the Contractor. Data is made available for the convenience of the Contractor.
- 2) In addition to any report that may be made available to the Contractor, the Contractor is responsible for performing any other soil investigations he/they feel(s) is necessary for proper evaluation of the site for the purposes of planning and/or bidding the project, at no additional cost to the City of Lynchburg.

1.9 COORDINATION

- A. At the direction of the City Engineer, temporary bypass pumping of sewerage flow may be required to be provided. See Section 02730 – *Sanitary Sewer* for bypass pumping requirements and procedures.
- B. Refer to Section 02660 – *Water Distribution* for valve operation requirements.
- C. Coordinate tie-ins to municipal system with the City of Lynchburg.
- D. When traffic signals or their appurtenances are likely to be damaged or interfered with as a result of the construction, coordinate temporary operation with the City of Lynchburg Traffic Engineer. Provide a minimum of 48 hours notice prior to anticipated disturbance or interruption.
- E. **Benchmark/Monument Protection:** Protect and maintain benchmarks, monuments or other established reference points and property corners. If disturbed or destroyed, replace at own expense to full satisfaction of Owner/City of Lynchburg.

PART 2 – PRODUCTS

2.1 SOIL MATERIALS

Provide borrow material when sufficient satisfactory soil material is not available from excavations.

2.1.1 MATERIAL CLASSIFICATION

- A. **Excavation:** All excavation material shall be classified as either Unclassified Earth Excavation or Rock.
- B. **Off-site Borrow:** Off-site borrow shall be select fill material approved by the City Engineer from an off-site borrow source. See [paragraph 1.3](#) of this specification for the definition of select fill material.

- C. **Riprap and Riprap Bedding:** See the Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, **Virginia Erosion and Sedimentation Control Handbook**, latest edition.
- D. **Topsoil:** Topsoil meeting the definition prescribed in [paragraph 1.3](#) obtained either from on-site or an off-site source.

2.1.2 SOIL CLASSIFICATION

- A. **Satisfactory Soils:** Non-plastic soils as defined by ASTM D 2487 soil classification group (Unified Classification System) (such as SW, SM, and SC); free of rock or gravel larger than 3 inches in any dimension, debris, organic matter, waste, frozen materials, muck, roots, vegetation, and other deleterious matter.
- B. **Unsatisfactory soils:** Plastic soils as defined by ASTM D 2487 soil classification group (such as ML, CL CH, MH, OH, OL and PT); soils which contain rock or gravel larger than 3 inches in any dimension, debris, organic matter, waste frozen materials, vegetation, and other deleterious matter. Unsatisfactory soils also include satisfactory soils not maintained within 20-percent of optimum moisture content at time of compaction, unless otherwise approved by either the City Engineer or a Geotechnical Engineer.

2.2 MISCELLANEOUS

Geotextile Fabric: See the Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, **Virginia Erosion and Sedimentation Control Handbook**, latest edition.

PART 3 – EXECUTION

3.1 GENERAL

3.1.1 GENERAL REQUIREMENTS APPLYING TO ALL AREAS

- A. Contractor shall plan construction to minimize disturbance to properties adjacent to the project site and be within the construction limits shown on the plans.
- B. The City Engineer reserves the right to limit the width of land to be disturbed and to designate on the drawings or in the field certain areas or items within this width to be protected from damage.
- C. Any grading or excavation required for equipment travel during the course of construction as well as erosion control, access or haul road installation and removal, restoration, seeding and ground cover shall be provided by the Contractor.
- D. The Contractor shall be responsible for damage to areas or items designated by the City Engineer to be protected. Repairs to, replacement of, or reparations for areas or items damaged shall be made at the Contractor's expense and to the satisfaction of the City Engineer before acceptance of the completed project.

- E. Any fences disturbed by the Contractor shall be repaired to a condition equal to or better than their original condition or to the satisfaction of the City Engineer at no additional cost.
- F. Contractor shall obtain written permission from property owners for use of any access other than ones located within rights-of-way. Written permission shall contain conditions for use and restoration agreements between property owner and Contractor. No additional compensation will be made for such access.
- G. All areas disturbed shall be restored to a condition equal to or better than their original condition and shall be graded to drain.
- H. The Contractor shall replace or repair all damaged or destroyed hedgerows and property corners. Protection of existing and restoration of damaged or destroyed property corners shall be in accordance with the requirements of Section 01000 – *General Requirements* – Construction Staking.

3.1.2 PROTECTION OF EXISTING UTILITIES

- A. Contractor is responsible for protection of existing utilities in accordance with Section 01000 – *General Requirements*.
- B. Should it become necessary to move the position of any underground structure, the Contractor may be required to do such work and shall be paid on a force account basis or on an extra work basis as specified in Section 01000 – *General Requirements*. Method of payment shall be agreed upon by the City Engineer and the Contractor prior to commencing work.
- C. If existing utilities are found to interfere with the permanent facilities being constructed under this section, immediately notify the City Engineer and secure instructions. Do not proceed with permanent relocation of utilities until instructions are received from the City Engineer.

3.2 CLEARING AND GRUBBING

- A. This work shall consist of clearing, grubbing, removing, and disposing of all vegetation and debris within the limits of construction, as designated on the plans or as required by the City Engineer. The Contractor shall remove only those trees and shrubs absolutely necessary to allow for the construction. The work shall also include the preservation from injury or defacement of all vegetation or objects designated to remain.
- B. The area within the limits of construction or as designated shall be cleared and grubbed of all trees, stumps, roots, brush, undergrowth, hedges, heavy growth of grasses or weeds, debris and rubbish of any nature which, in the opinion of the City Engineer, is unsuitable for foundation material. Nonperishable items that will be a minimum of five feet below the finish elevation of the earthwork or slope of the embankment may be left in place.

- C. The Contractor shall provide barricades, fences, coverings, or other types of protection necessary to prevent damage to existing improvements, not indicated to be removed, and improvements on adjoining property. All improvements damaged by this work shall be restored to their original condition or to a condition acceptable to the owner or other parties or authorities having jurisdiction.
- D. **Protection of Trees and Vegetation:** Contractor shall protect existing trees and other vegetation indicated by the City Engineer to remain in place against cutting, breaking, or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary fences or barricades as required to protect trees and vegetation to be left standing at no additional cost.

Trees and shrubs that are to remain within the construction limits will be indicated on the drawings or conspicuously marked on site. Unless otherwise noted, trees within the construction limits shall become the property of the Contractor and shall be removed from the site.

Carefully and cleanly cut roots and branches of trees indicated to remain where the roots and branches obstruct construction of the utility line. The Contractor shall provide protection for roots and branches over 1 ½ inches diameter that are cut during construction operations. Temporarily cover all exposed roots with wet burlap to prevent roots from drying out. Provide earth cover as soon as possible.

Damaged trees and vegetation designated to remain shall be repaired or replaced at Contractor's expense in a manner acceptable to the City Engineer if they are damaged by construction operations. Repair tree damage as directed by a qualified tree surgeon.

- E. All brush, tree tops, stumps, and debris shall be hauled away and disposed of in accordance with all applicable laws and regulations. The contractor shall clean up debris resulting from clearing operations continuously with the progress of the work and remove promptly all salvageable material that becomes his property and is not to be reused in construction. Sale of material on the site is prohibited. Debris from the site shall be removed in such a manner as to prevent spillage. Keep pavement and area adjacent to site clean and free from mud, dirt, dust, and debris at all times.
- F. The method of stripping, clearing and grubbing the site shall be at the discretion of the Contractor. However, all stumps, roots and other debris protruding through the ground surface or in excavated areas shall be completely removed to a minimum depth of 18 inches below surface and/or subgrade whichever is lower and disposed of off the site by the Contractor, at his expense.
- G. **Marginal Areas:** In marginal areas, with the City Engineer's permission, remove trees where the following conditions exist.

- 1) **Root Cutting:** When clearing up to the "clearing limits," the Contractor shall also remove any tree which is deemed marginal such that when the roots are cut and the tree could be rendered unstable by the affects of high winds and in danger of toppling into either the right-of-way or onto private property.
- 2) **Slender Bending Trees:** Where young, tall, thin trees are left unsupported by the clearing operation, and are likely to bend over into the right-of-way, the Contractor, during the clearing operation, shall selectively remove those trees which are located outside and adjacent to the clearing limits and City right-of-way or easement as well. During the course of construction and during the one-year warranty period, the Contractor shall remove such young trees that overhang into the right-of-way or cleared area.

- H. Remove the existing topsoil to a depth of 6 inches or to the depth encountered from all areas in which excavation will occur. The topsoil shall be stored in stockpiles, separate from the excavated material, if the topsoil is to be respread. Otherwise material shall be disposed of off-site at the Contractor's expense.

3.3 UNCLASSIFIED EXCAVATION, UNDERCUTTING, BORROW, EMBANKMENT:

3.3.1 DESCRIPTION

Prior to beginning grading or embankment operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with these specifications.

Should the Contractor, through negligence or other fault, excavate below the designated grades, he shall replace the excavation with approved satisfactory materials, in an approved method, at his own expense. All material determined unsatisfactory shall be disposed of in waste areas as directed. Topsoil shall not be used in embankments but shall be handled and placed as directed.

The Contractor shall satisfy himself as to the character, quantity, and distribution of all materials to be excavated. No payment will be made for any excavated material that is used for purposes other than those designated.

3.3.2 CONSTRUCTION METHODS

- A. **Excavation:** Excavation shall be performed as indicated on the plans or as directed by the City Engineer to the lines, grades, and elevations, and shall be finished to a reasonable smooth and uniform surface. During the process of excavation, the grade shall be maintained and surface shall be rolled so that it will be well drained at all times.

When solid rock is incurred in the excavation, the rock shall be removed to a minimum depth of 12 inches below the surface of the subgrade. Material unsatisfactory for subgrade foundation shall be removed to a depth specified to provide a satisfactory foundation. The portion so excavated shall be refilled with suitable material obtained from the grading operations or borrow area and thoroughly compacted by rolling. Material obtained from on site grading operation must be approved by the City Engineer. For areas that do not require fill, scarify and compact to a depth of 6 inches.

Any removal, manipulation, aeration, replacement, and recompaction of suitable materials necessary to obtain the required density shall be considered as incidental to the construction operations, and shall be performed by the Contractor at no additional cost to the City.

No rock, stone, or rock fragments, larger than 3 inches in their greatest dimension will be permitted in the top 12 inches of the subgrade. No rock, stone, or rock fragments larger than 8 inches in their greatest dimension will be permitted in the remainder of the fill.

- B. **Stabilization of Soft Subgrade with Geotextile:** The use of Geotextile material for subgrade stabilization shall be approved by the City Engineer and shall meet all applicable VDOT standards and specifications.
- C. **Borrow:** Borrow shall not be used until all suitable, on-site, excavated material has been placed in the embankment, unless authorized by the City Engineer. Unless otherwise designated on the plans and contract documents, the Contractor shall make his own arrangements for obtaining select fill material for borrow and pay all costs involved. If the Contractor places more borrow than is required, and thereby causes a waste of excavation, the amount of such waste, unless authorized, will not be included for payment.

D. Embankments

- 1) **Evaluation of Subgrade:** Prior to placement of compacted fill, the City Engineer or his representative shall carefully inspect the exposed subgrade. The Contractor shall then proof roll the exposed subgrade, in the presence of the City Engineer or his representative. The inspection shall include, but not be limited to, proofrolling the prepared subgrade with a rubber-tired fully loaded dump truck that has a minimum gross weight of at least 20,000 pounds (10 tons). No other method will be acceptable. Any unsatisfactory materials thus exposed shall be removed and replaced with satisfactory select material as approved by the City Engineer. Provide the necessary amount of select fill compacted to the density requirements outlined in this specification.
- 2) **Preparation of Ground Surface for Embankments or Fills:** Before fill is placed, scarify existing grade to a minimum depth of 6 inches. In areas where the existing or proposed ground surface is steeper than one vertical to four horizontal, plow surface in a manner to bench and break up surface so that fill material will bind with the existing surface.
- 3) Embankments shall be made of satisfactory soil material and shall be built in successive horizontal layers of not more than 8 inches in loose depth for the full width of the cross sections.

The material entering the embankment in each of the layers shall be within a tolerance of plus or minus 20% of the optimum moisture content before rolling to obtain the prescribed density. Wetting or drying of the material and manipulation when necessary to secure uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work on the embankment shall be delayed until such time as the material has dried to the required moisture content. If high moisture is due to negligence of contractor due to improper drainage, the City Engineer may require removal and replacement of material.

Fill material shall not be placed on frozen ground or areas covered with ice and/or snow or areas with a moisture content above optimum.

E. Preparation of areas to receive asphalt pavement or concrete

- 1) **Areas to be Paved:** After all excavation, undercutting, and backfilling has been completed, the subgrade shall be properly shaped and thoroughly compacted. The compactive effort shall include all areas beneath pavement and shall extend at least a minimum of 1 foot behind the paving limits. Compaction shall be in accordance with Table 02200-1.
- 2) **Curb and Gutter, Sidewalks and Driveway Aprons:** The subgrade shall be constructed true to grade and cross section as may be shown on the drawings. Compaction shall be in accordance with Table 02200-1.

All subgrade shall be graded and protected as to prevent an accumulation or standing water, and consequent subgrade saturation, in the event of rain.

F. Grading Tolerances of Finished Surface: Earthwork shall conform to the lines, grades, and typical cross sections shown on the plans or as established by the City Engineer. Changes in grade shall be accomplished by smooth curves.

- 1) Shape subgrade under pavement and curb and gutter to within ½ inch of required subgrade elevations.
- 2) Finish pavement and curb and gutter to within ½ inch of required finish elevations.
- 3) Shape subgrade under sidewalks to within 0.10 foot of required subgrade elevations.
- 4) Finish sidewalks to within 0.10 foot of required finish elevations.
- 5) For all other areas, subgrade and finish elevations shall be within 0.10 foot of required corresponding elevations.

G. Backfill of Curb and Gutter and Sidewalks: Immediately after the removal of forms for curb and gutter, sidewalks and driveways, the space between the back of the curb, sidewalks, and driveways shall be backfilled and smoothed off in a manner to prevent the accumulation of standing water.

3.4 SUBGRADE COMPACTION TESTING AND CONTROL

- A. **Municipal Projects:** For municipal projects, the City may employ and compensate a Geotechnical testing firm to provide soils testing and inspection services.
- B. **Private Projects:** For private development projects which involves proposed City-owned infrastructure the developer, at the discretion of the City Engineer, may be required to employ a Geotechnical testing firm to perform the testing and provide copies of the tests reports to the City for approval and record.
- C. **All Projects**

1) Minimum Compaction Testing Frequency

Location	Frequency
Buildings and structures	1 test group ^a for every 5,000 square feet
Road	1 test group for every 300 feet of road
Parking Lots	1 test group for every 10,000 square feet
Unpaved areas	1 test group for every 20,000 square feet
Pipe Trench	1 test group for every 300 feet

^a One test group consists of compaction tests on each layer of fill and backfill material.

- 2) In the absence of a pre-construction Geotechnical investigation, the Geotechnical testing firm is to perform laboratory Proctor tests to establish a moisture-density relationship for all materials that are proposed to be used as fill.
- 3) Contractor shall give a 24-hour notice to Geotechnical testing firm when ready for Proctor, compaction, or subgrade testing and inspection.
- 4) Should any moisture-density test fail to meet specification requirements, the Contractor shall perform corrective work necessary to bring the material in compliance and retest the failed area at no additional cost to the City.

3.5 SUBGRADE PREPARATION AND COMPACTION REQUIREMENTS

- A. **Minimum Compaction Requirements:** Compaction percentages are percentages of maximum dry density as determined by indicated ASTM Standards. Unless otherwise directed by a Geotechnical Engineer, the material shall be placed at plus or minus 20% of optimum moisture content.

Table 2200.1	
Minimum Compaction Limits	
Location	Density
Beneath and within 25 feet of buildings	100% of the maximum dry density by ASTM D 698 (Standard Proctor), AASHTO T-99.
Areas under roadway pavement surfaces, shoulders, sidewalks, and curb and gutter	95% of the maximum dry density by ASTM D 698 (Standard Proctor), AASHTO T-99.
Under turf, sodded, planted, or seeded non-traffic areas	90% of the maximum dry density by ASTM D 698 (Standard Proctor), AASHTO T-99.

- B. Failure of Compactive Efforts:** If compaction efforts should fail to provide a stable subgrade, after subgrade materials have been shaped and brought to optimum moisture, such unstable materials shall be removed to the extent directed by either the Geotechnical Engineer or the City Engineer and replaced and compacted using new select material.

3.6 STRUCTURES: EXCAVATION, FILLING, AND BACKFILLING

See Section 02220 - *Trenching, Backfilling, and Compaction of Utilities* for excavation and backfilling for structures (manholes, etc.). See *VDOT Road and Bridge Specifications* for excavation and backfilling for retaining walls.

3.7 METHOD OF VOLUME MEASUREMENT

Contractors are required to furnish accurate counts of all excavation and/or fill moved which is to be paid for under the Contract unit price. The volumes shall be measured by either "truck tally" or by "cross-sectioning," whichever method is approved by the City Engineer or stated in the proposal and/or bid documents. When a truck count is used, the City Engineer or their representative shall verify the count independently.

A. Truck Tally Method

Excavation: When unclassified excavation or undercut volumes are to be counted by the truck tally method, "swell" is to be incorporated into the truck volume in the amount of 15%. Unless otherwise agreed to or justified by a Geotechnical Engineer, the following pay volumes are to be used for either unclassified or undercut excavation:

Tandem: 13 CY
Tri-axle: 15 CY

Borrow: When either off-site or on-site borrow is to be counted by the truck tally method, "shrinkage" is to be incorporated into the truck volume in the amount of 15% (shrinkage of truck volume placed compared to compacted fill volume) utilizing the following pay volumes:

Tandem: 10 CY
Tri-axle: 12 CY

Loading Truck: A qualified truck load is one that is loaded up to within approximately 6 inches of the top of the dump bed, prior to dumping.

B. Average-End-Method

Excavation and fill can be computed using the average-end-method. When used, this method is to be employed using the existing contours shown on the Contract Drawings and the Contractor's actual surveyed finished contours (surveyed by a licensed Professional Surveyor). In so doing, the finished contours are to be plotted at the same scale as the original drawing and a transparency furnished to the Engineer for comparison to design grades. The volume computations are also to be submitted along with the Surveyor's seal and a certification as to the volumes measured.

The Contractor, at his discretion and with the prior approval of the Engineer, may survey the "stripped" site (the site after topsoil has been removed) and compute the volumes based on the stripped site and the "designed" finished grade as shown on the Contract Drawings. As before, a transparency to the same scale and the Surveyor's computations and certification are to be submitted to the Engineer for comparison and verification.

C. Volume Formulas

Unless otherwise approved, the following formulas are to be used in computing cut and fill:

Fill Formula

Net Fill = Raw Fill Vol. – Unclassified Excavation X (1 - Shrink Factor) + Strip Vol. - Undercut or waste Fill placed in Fill Slopes X (1 - Shrink Factor) - Pavement Section or Building Floor Pad

Cut Formula

Net Cut = Raw Cut - Strip Vol. + Pavement Section or Building Floor Pad

End of Section 02200

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